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A NEW DEFINITION OF ERGONOMICS

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Abstract In this paper, a global analysis of definitions of ergonomics has been presented. In addition, a new definition of Ergonomics has been given. The main objective of this comprehensive definition is to help experts in explaining the concept of ergonomics, but also to concisely and accurately present the essence of this scientific discipline to students, and people who want to acquire basic knowledge in this field.

Keywords: Ergonomics definition.

1. INTRODUCTION

Ergonomics is certainly one of the very few sciences that originates from the period of the beginning of civilization. In fact, when a primitive man made the first ax in the Paleolithic Era and adjusted its shape to the anatomy of the human hand, he unconsciously laid the foundations of the Ergonomics. Ergonomic principles and laws at that time were applied on the intuitive basis.

However, Ergonomics as a science was formed much later. It is difficult to say the exact date of its establishment as a scientific discipline. Throughout the history, there were more independent ergonomic considerations and scientific research in different parts of the world. The connection between work and health problems was mentioned in ancient Egypt, as well as in the Greek and Roman period. In the book "*De morbis artificum diatriba*" by Bernardino Ramazzini (Italian physician, 1633-1714), the connection between working conditions and pathology was first established from an occupational health perspective. In this book, the effects of awkward working postures on bodies of metal mining workers also were referred to as diseases [1].

For the development of any scientific field is of primary importance the publication of scientific literature and the establishment of institutions, which deal with science in an organized way. In that sense, at the beginning of the twentieth century occurred important changes, which have accelerated the formal constitution of Ergonomics as a science. In this regard, the establishment of the Kurashiki Institute of Science of Labor in 1921 in Japan can be mentioned, as well as publishing of a book "*Research of Efficiency: Ergonomics*" by Tanaka in the same year, also in Japan [1].

Events related to the period of the First and Second World War have certainly contributed to the formation of ergonomics. It was necessary to design the technical means of combat in a way that increases the efficiency of their use, i.e. reduces the number of errors during use. For this purpose, experts were engaged, whose job was to solve these problems by the application of ergonomic solutions.

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Word ergonomics was coined by Wojciech Jastrzębowski, in 1857 in his book "*An outline of Ergonomics, or the Science of Work*" (the book was originally written in Polish). Term ergonomics has been derived from the Greek *ergon* (work) and *nomos* (laws) to indicate the science of work. The word ergonomics has again become topical in 1949, when the K F H Murrell brought together a working group in the British Admiralty, which was composed of people who at that time dealt with issues that fall within the scope of ergonomics. From that moment on, the term ergonomics begins to be frequently used around the world. Publishing of books in the field of ergonomics began in the middle of the last century. Printing of the scientific journal "*Ergonomics*" began in 1957. University programs in this field also were organized. International Ergonomics Association (IEA) was established in 1959, which indicates that at that time Ergonomics was recognized worldwide, and organized as a scientific discipline.

2. ANALYSIS OF EXISTING DEFINITIONS OF ERGONOMICS

As it can be seen from the introductory part, as a science with the long practical application, Ergonomics has come a long way, starting from the development of first hand tools, through the evaluation and improvement of working conditions, to its application in complex cosmic systems. It is understandable that the scope of study, as well as the number of scientific subfields that ergonomics involves, were increased continuously. The number and types of methods that were used in ergonomic studies have also been increased.

In the meantime, a number of definitions of ergonomics have been formed. One of the reasons for such a great variety of definitions may be the evolution of ergonomics as a science. The most concise definition of ergonomics is contained in its name - the natural laws of work. Until today, more than 100 definitions of ergonomics have been formed. These definitions differ to a greater or lesser extent. Each of these definitions encompasses and describes at least one essentially important trait of ergonomics.

It should be noted that the expression "human factors" is often utilized interchangeably with "ergonomics" [2]. The term human factors is more commonly used in the Americas, whereas the term ergonomics has its origins in Europe.

Sets of definitions of Ergonomics are given in [3-5]. An extensive list of definitions of ergonomics (31) has been given in [6], but also the definitions of some scientific disciplines that are close to ergonomics (e.g., Engineering Psychology). However, analysis of these definitions is hampered, because some "definitions" that are presented in [6] cannot be considered, in essence, as definitions in the formal sense of the word. It means that such descriptions (which explain what is ergonomics - human factors) may consist of several sentences or parts of sentences. Due to such construction, the aforementioned descriptions are useful, but do not have the concision that one concrete definition should have.

In [5] are given several general definitions of ergonomics. In addition, the analysis of a large number of definitions was performed. Taking into account the above mentioned analysis, all definitions can be classified into three groups. The first group consists of short, dictionary type definitions (e.g., "man-machine interface"). The second group consists of moderate-length definitions (e.g. "The interface between people and machines in systems"). The third group consists of much longer

definitions, which provide contents and goals of the field (e.g. "... is a body of knowledge about human abilities, human limitations and other human characteristics that are relevant to design").

In [7] was performed a detailed analysis of more than 100 definitions of ergonomics from different references. The mentioned analysis was based on the selection of keywords from collected definitions. The authors have determined the frequency of selected keywords in all the collected definitions. Table 1 in descending order shows an overview of the number of occurrences of certain keywords in definitions of Ergonomics (which were derived and selected from the definitions of Ergonomics).

Table 1. The frequency of occurrence of certain words in the definitions of Ergonomics (Human Factors), based on [7].

keyword	frequency	keyword	frequency	keyword	frequency
human	180	technology	13	experimental	7
designing	114	procedures	12	errors	7
systems	104	interaction	12	satisfy	7
machines	69	developing	12	stress	7
work	68	evaluation	12	used	7
engineering	64	field	12	aspects	6
environment	58	operators	11	organizations	6
applying	57	personnel	11	anthropology	6
equipment	55	activities	11	results	6
using	52	workplace	11	helps	6
science	48	factors	11	reducing	6
performing	48	productivity	11	suitable	6
people	45	engineers	11	adapting	6
job	37	biology	11	components	5
limitations	34	abilities	11	parts	5
man	32	maintaining	10	accomplishment	5
operating	32	methods	10	purpose	5
capabilities	31	industrial	9	conditions	5
studying	31	objectives	9	health	5
efficiency	30	training	9	accuracy	5
discipline	28	requiring	9	selecting	5
characteristics	29	profession	9	accommodating	5
products	25	beings	8	acceptable	5
psychology	25	problems	8	seeks	5
effective	25	things	8	analyzing	5
relations	25	integrating	8	devices	4
behaving	24	variables	8	play	4
tasks	23	anatomy	8	intent	4
users	23	controlling	8	places	4
fitting	23	specifying	8	effects	4
knowledge	22	minimizing	8	cognitive	4
improving	20	measuring	8	designers	4
physical	20	area	8	interdisciplinary	4
physiology	18	branch	8	psychosocial	4
life	17	focusing	8	maximizing	4
principles	17	persons	7	exploiting	4
considering	16	individuals	7	creating	4
research	16	workers	7	serving	4
data	15	facilities	7	supporting	4
tools	15	groups	7	processing	4
information	14	aims	7	matching	4
man-machine	14	relate	7	approach	4
goal	13	enhancing	7	systematic	4
comfort	13	medical	7	understanding	4

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3. DEVELOPMENT OF A NEW DEFINITION OF ERGONOMICS

Bearing in mind a large number of already established definitions of Ergonomics, a question arises about the justification of creating any new definition in this scientific field. However, author of this paper considers that there is such a need, at least for two reasons. Although different, these reasons are closely related.

The first reason has to do with the population of people for whom the definition is intended. People who work in the field of ergonomics know from experience what is ergonomics. If they do not focus deeper on the content of some definition of ergonomics, almost every definition of ergonomics can look good and justified to them. However, for people who get introduced to ergonomics, especially for students, every definition of ergonomics is not of equal importance. The authors of definitions of ergonomics often "forget" the fact that the Ergonomics is a multidisciplinary science. They come from different professions, so it's not a rare case while creating a definition that they put an emphasis on a certain aspect of Ergonomics, which dominates in the profession in which they work. Due to this, some other aspects of ergonomics that are also important remain deprived to readers and listeners, without sufficient experience in this scientific area.

The second reason is connected with the completeness of definitions of ergonomics. Unfortunately, there are still a small number of people who know what Ergonomics is. In many dictionaries, there is still no definition for this word. In addition, in some dictionaries it is possible to find a definition of ergonomics, which does not correspond to the essence of Ergonomics. For this reason, it is of great significance to convey a definition of Ergonomics to the people who are acquainted for the first time with ergonomics, which as a whole and adequately describes what ergonomics means and what it involves. With this in mind, the definition of ergonomics should have a comprehensive character. This is especially important for students who will be able to identify on the basis of such comprehensive definition, whether a problem falls into the domain of ergonomics or not. Also, such definition should provide an insight into how students should approach in order to solve a problem from the ergonomic aspect.

However, a small number of definitions of ergonomics have such a comprehensive character. This primarily relates to short definitions of ergonomics. Let's take as an example the definition stating that ergonomics deals with the study of a man - machine system. Although this definition is true, it is not complete. For example, to a reader with no experience, it will not be clear which aspect of the interaction between man and machine it includes. Psychological, or maybe physiological? If a definition does not contain the required amount of information, it leaves the possibility of making the wrong conclusion, or creating a vague impression about the notion that it explains.

During the formation of a definition of ergonomics, it is also necessary to take into account several important moments. In this regard, a definition of Ergonomics should:

- Indicate that it is originally linked to the study of problems of people at work
- Highlight that Ergonomics is a science
- Indicate that the Ergonomics is a multidisciplinary field
- Point out from which aspects the Ergonomics approaches to the evaluation of problems
- Point out that the Ergonomics is a field that on the basis of quantitative and qualitative research comes to conclusions and solutions (as opposed to the scientific disciplines that present solutions

primarily on the basis of descriptive or qualitative research), as well as that it possesses its own methodology
- Indicate that the ergonomics not only refers to the assessment of existing solutions, but it also contributes towards the formation of new, improved solutions
- Indicate the aspects that ergonomics can improve while designing (comfort, safety ...)
- Point out the goal of Ergonomics
- Point out the interaction of man with various elements from the environment.

Considering all that has been said, a new definition of ergonomics has been formed, which reads:

Ergonomics is a multidisciplinary science whose goal is to examine the impact of means of work, conditions of work, processes of work, and products as results of work on humans from the psychological, physiological, anatomical, biomechanical, sociological, organizational and physics aspect by applying the quantitative and qualitative research methods, as well as to adapt the design of the aforementioned elements to humans, with the aim of improving comfort, safety, efficiency and satisfaction, which are considered during their interaction with humans.

As can be observed, this definition does not deviate from its basic determinant - definition, which is contained in the very name of ergonomics. On the contrary, it expands and supplements the basic definition. On the basis of a comparison of keywords contained in the new definition of Ergonomics and keywords that are shown in Table 1, two sub-groups of keywords may be distinguished. The first subgroup consists of the following keywords:

• Method (10)
• Organizational (organizations - 6)
• Impact (effects - 4)
• Conditions (4)
• Adapt (adapting - 6)
• Satisfaction (satisfy - 7)
• Comfort (13)
• Interaction (12)

These are the keywords that are contained in the new definition of Ergonomics, as well as in Table 1. Numbers in parentheses indicate in how many definitions of ergonomics were listed keywords previously included. Words that are shown in brackets, in essence, indicate the identical form (meaning) of words that were used in the previously formed definitions. It can be observed that some very important words (such as comfort or interaction) were relatively rarely used in the previous definitions of ergonomics.

The second sub-group consists of the following keywords:

• Multidisciplinary
• Examine
• Processes
• Sociological
• Quantitative

• Qualitative
• Safety
• Biomechanical
• Physics

These are keywords that are contained in the new definition of Ergonomics, but are not present in Table 1. Surprising is the fact that the keyword Safety, which is very important for the explanation of ergonomics was not present in many previous definitions, even though it was present in the descriptions and broader explanations of ergonomics.

4. CONCLUSION

Although the new definition of Ergonomics may seem complex or long to someone, it describes in just one sentence the essence of ergonomics. This definition is intended to help experts in the field of ergonomics in the explanation relating to this scientific discipline. The main objective of this new definition is to provide fast, accurate and comprehensive insight into the essence of this scientific field to students and other people who want to get acquainted with ergonomics and its application in practice.

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